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MOMILANI VILLA
SOIL EXPLORATION REPORT

MANANA-UKA AND WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: 10 AND 9-7-25: 13

To:
PARK ENGINEERING, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

NOVEMBER 21, 1973

WALTER LUM ASSOCIATES, INC.

CIVIL, STRUCTURAL, SOILS ENGINEERS

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November 21, 1973

PARK ENGINEERING, INC.
1149 Bethel Street, Room 710
Honolulu, Hawaii 96813

Gentlemen:

Subject: Momilani Villa
Soil Exploration Report
(for site grading for residential development)
Manana-Uka and Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 and 9-7-25: 13

In accordance with your request, soil explorations were made to evaluate general soil conditions at the proposed residential development site for Momilani Villa at Manana-Uka and Waiawa, Ewa, Oahu, Hawaii.

The surface soils at the site may be generally described as stiff to hard, brown clayey silts and silty clays (MH soils) with clay (CH soils) pockets and decomposed rock mixed with cobbles and boulders.

Grading of the site is contemplated. The earthwork should be done in accordance with the requirements of the Revised Ordinances of Honolulu, 1969 As Amended and the recommendations contained herein.

The proposed light residential structures may be supported on post-and-beam foundations on the stiff existing ground or on compacted fills constructed from the on-site soils.

This report includes a Boring Location Sketch, boring logs, laboratory test results, recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike
Ezra Koike

JWS/EK:rmf

C O N T E N T S

MOMILANI VILLA
SOIL EXPLORATION REPORT

MANANA-UKA AND WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: 10 AND 9-7-25: 13

SCOPE OF EXPLORATION

The purpose of this exploration was to evaluate general soil conditions for site grading for residential development for the proposed Momilani Villa at Manana-Uka and Waiawa, Ewa, Oahu, Hawaii. A reconnaissance report of soil conditions for site development studies was previously made for Palisades Golf Course Subdivision, August 24, 1973.

This report includes field explorations, laboratory tests, general recommendations for building foundation design and limitations.

FIELD EXPLORATION AND LABORATORY TESTS

Nine borings were made at the site at the approximate locations shown on the Boring Location Sketch.

Borings were made with 4-in. diameter augers using a finger type bit. Soil samples were recovered with 2-in. thin-wall tube samplers and a 2-in. standard split spoon sampler driven with a 140-lb hammer falling 30 inches.

Laboratory tests included: natural water content, Atterberg limit, specific gravity, AASHO T-180-57 density, expansion and CBR.

A summary of the laboratory test results is given in Tables IA thru IC.

SOIL CLASSIFICATION SYSTEM

Soil samples were visually observed and subjected to appropriate tests in the laboratory. Based on visual observations and laboratory tests, the soil descriptions given on the boring logs are generally made in accordance with the "Unified Soil Classification System."

GEOLOGIC AND SOIL CLASSIFICATIONS BY OTHERS

From a review of geologic literature and the U. S. Soil Conservation Service maps of the area, the soils may be generally described as older alluvium formed by the weathering of alluvial fan and talus deposits.

Stearns, H. T. and U. S. Geological Survey "Geologic and Topographic Map, Island of Oahu, USGS 1938":

Qa - Consolidated noncalcareous deposits, older alluvium.

U. S. Soil Conservation Service, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii," August 1972:

The soils are classified as Kawaihapai stony clay loam or sandy loam, 2 to 6% slopes, KlaB

Unified Soil Classification - CL and SM

GENERAL SITE CONDITIONS

Site Location

The proposed site is located on the south side of Waimano Valley at the foot of the ridge below

Waimano Home Road. Komo Mai Drive is located uphill or south and east of the site.

Annual Rainfall

The average annual rainfall may vary from 30 to 40 inches.

Topography

The existing ground slopes down towards Waimano Stream (north) at about 5 to 10% gradients. Slopes of about 20 to 30% or steeper were noted along the southerly boundary. Next to Waimano Stream, steeper slopes form the bank of the stream.

The area is mostly grassed. The site was formerly part of a golf course and driving range area. A clubhouse and A.C. paved parking lot are located at the southeast corner of the lot.

An A.C. and concrete access road crosses the eastern portion of the site and terminates at the City and County of Honolulu sewage treatment plant which is located across Waimano Stream from the site.

Some loose stockpiles of soil and rock were noted along the north and northwest boundaries of the site next to Waimano Stream.

INTERPRETATION OF SOIL CONDITIONS

From the field exploration and laboratory test results, the soils encountered in the borings may be generally approximated for most of the site as follows:

> Stiff to hard, brown clayey silts and silty clays (MH soils) with clay (CH soils) pockets and decomposed rock mixed with cobbles and boulders to about 15 to 20 ft, the maximum depths drilled.

Water was noted in Boring No. 1 at about 16-ft depth during the field explorations.

Variations to the above soil conditions are to be expected in localized areas. For more detailed descriptions of soils encountered in the borings, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

The present plan is to develop the flatter central portion of the site for a residential subdivision. An access roadway is proposed from Komo Mai Drive into the site.

The proposed grading is to use cuts and fills generally less than 15 ft in height.

Decomposed rocks and boulders were encountered at about 1 to 20-ft depths in some borings. Because of the shallow depths to decomposed rocks, boulders will probably be found interspersed over the site. The closer an excavation approaches decomposed rocks, the greater will be the quantity of boulders.

Along the entrance road to the subdivision from Komo Mai Drive, about a 10-ft fill and a retaining wall are proposed at the top of the steep bank. The retaining wall should be set as far back from the top of slope as practicable. The bottom of footing should extend well below the surface so that there is sufficient stiff natural material in front of the toe of the wall.

The on-site soils are somewhat expansive. To minimize the expansive effects, the site should be graded to drain water away from the buildings.

<u>Site Grading</u>

In general, site grading should be done prior to building construction and in accordance with the requirements of the Revised Ordinances of Honolulu, 1969 As Amended and as recommended below:

1. The area should be cleared and grubbed. Surface vegetation and miscellaneous debris should be cleared and removed prior to site filling.

2. Where fill is contemplated, the existing stockpiled soil should be stripped to stiff

ground before the start of fill construction. Loose surface soils and localized soft pockets should be stripped to stiff natural ground before the placement of fills. Loose surface soils at finish grade should be scarified and recompacted.

3. Existing hard surfaces such as access roadways, etc., should be scarified down to stiff natural soils and recompacted to match the density of the surrounding stiff soils.

4. Where fills are proposed on sidehill areas, gullies and natural drainageways, loose material at the bottom and sides should be stripped down to stiff ground before the placement of fills.

   Subdrains should be placed along the bottom of natural drainageways with laterals in a herringbone pattern along the sides of the drainageways.

5. Thin sidehill fills (sliver fills) on sloping areas should be avoided when practicable.

Otherwise, the existing slopes should be stripped of loose material and the outer 8 ft of the slope should be reconstructed by cutting and keying into the existing slope.

6. Fills should be constructed in approximately level layers starting at the lower end and working upward. Where fills are made on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the fill should be benched to a generally level condition. As the fill is brought up, it should continually be keyed into stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.

7. If boulders are proposed to be used in the construction of fills, they should be generally placed along the toe sections of fill slopes and outside of probable building sites. Before placing any boulders, the subgrade should be stripped to stiff natural ground and shaped to drain. A layer of select material or low grade

concrete should be placed on the subgrade before constructing the base of the wall. The void spaces between boulders should be filled with smaller granular material. A blanket of filter material should be placed against the boulders before any earth fills are placed against the boulders. See attached sketch, Figure 1.

8. Where practicable, fills should be laid in 6-in. compacted layers to 90% of the maximum density determined by the AASHO T-180-57 test method. In roadway areas, the top 2 ft of fill should be compacted to 95% of the maximum density.

9. The site should be generally graded to prevent ponding of water and to provide positive drainage away from the buildings.

10. Fills along the stream bank should be kept as low as practicable.

Loose material on the existing slope next to the stream bank should be stripped and new fills keyed into stiff ground. The fills along the stream bank should be constructed with fairly well-graded granular material, less than 6-in. size, less than 15% passing No. 200 sieve and plasticity index less than 10.

If practicable, buttress type fills or revetment walls should be considered along the banks of Waimano Stream.

Revetment Walls Along Bank of Waimano Stream

If revetment walls are used along Waimano Stream, the fill should be constructed by overfilling and compacting the slope, then cutting the slope back to grade. The wall may be constructed on the compacted slope, provided drains are installed behind the walls. The walls should be designed to resist hydrostatic pressure behind the walls.

The bottom of walls should generally extend down to about the stream level and rest on stiff natural ground; otherwise, toe protection should be provided to minimize the effects of scour. Some maintenance may be required should scour occur.

Retaining Wall Along Entry Road from Komo Mai Drive

About a 10-ft fill and retaining wall are proposed near the top of the existing bank for the entry road from Komo Mai Drive.

Because the existing bank is fairly steep, the retaining wall should be set as far back from the top of the existing slope as practicable. The base of wall should extend several feet below the existing ground and generally to a depth such that the distance from the toe of wall to the face of the existing slope would be about 2 to 3 times the base width of the wall. In addition, the bottom of footing excavation should be extended down to about a level below an imaginary plane drawn upward from Waimano Stream at about a 2 horizontal to 1 vertical ratio. Any clay "CH" pocket at the bottom of excavation should be removed. The excavation should be backfilled with select well-graded, granular material compacted in thin layers up to the footing level. Subdrains should be installed at the base of the excavation and should be daylighted at several points for drainage of the base. The road embankment along this portion of the roadway should be constructed with fairly well-graded granular material generally less than 6-in. maximum sizes (see Figure 2).

An alternate entry road design may be the use of a structurally supported ramp. This would minimize the fill loads along the top of existing slope.

Earth Pressures and Backfill

Fairly well-graded granular material or select granular material should be used for backfilling against the wall.

For walls resting on stiff natural ground, bearing values of about 3000 p.s.f. may be considered. Some increase for toe pressure may be considered.

For well-graded granular fills, lateral earth pressure equivalent to fluid pressure of about 40 p.c.f. may be used for a level backfill. In addition, lateral earth pressures should be added for anticipated vehicular loads.

If a sloping backfill is used above portions of the wall, the lateral earth pressure should be increased according to the Rankine theory, or using earth pressure charts by Terzaghi and Peck, or other accepted theory. The center of pressure should be considered to act somewhat above the lower third of the triangular fluid pressure diagram, assuming that subdrainage and drainage of the backfill are provided.

For sliding resistance between the base and subgrade, a coefficient of friction of 0.35 may be used provided the base of the wall is well drained, and there is sufficient (2 times the base) stiff natural material in front of the toe of the wall.

Erosion

Some erosion may take place at the toe of the wall resulting in some downhill creep of the wall. Some maintenance may be required should a washout or erosion occur at some localized area along the wall.

Slopes

In general, cut and fill slopes of 2 horizontal to 1 vertical or flatter should be used.

To minimize erosion, the runoff from rainstorms should be diverted by berms or ditches away from slopes whenever practicable.

The surface of fill slopes should be compacted by cat-tracking or with a sheepsfoot roller.

Slope planting is recommended on cut and fill slopes to minimize erosion.

Slope adjustments or other precautions may be necessary if seepage zones or expansive clay pockets are encountered in localized areas.

Foundations

For the proposed light residential structures, conventional post-and-beam construction may be used.

In general, building foundations should not be considered on sloping hillsides where the slopes are steeper than 3 horizontal to 1 vertical.

For slab-on-ground foundations, the soils may be slightly expansive. Each house pad for a slab-on-ground foundation should be checked before construction.

General recommendations for foundation design considerations are as follows:

1. Bearing values for a given soil usually vary with the size and depth of footings. For light, wood-frame structures, bearing values of about 2000 p.s.f. may be used for footings resting on stiff natural ground or on compacted fill.

2. Soft spots or pockets of loose material encountered in footing excavations or below the building area should be excavated and replaced with selected on-site or borrow soils compacted in thin lifts.

3. Concrete slabs on ground should be placed over a base course of 4 in. of well-graded gravel less than 3/4-in. and greater than 1/4-in. in size. The subgrade should be compacted and shaped to a level surface or to drain. If practicable, the subgrade generally should be kept slightly higher than the finish grade outside the building.

4. Because of the downhill creep effect of soils on a slope, some settlements may occur near the tops of slopes. Buildings, particularly slab-on-ground foundations, should generally be placed about 15 ft from the tops of slopes and preferably 20 ft or more from the tops of slopes next to Waimano Stream.

5. Construction of retaining walls on slopes for residential structures should generally be avoided. A buttress fill or revetment wall should be considered along the north and west boundaries of the site.

6. Good surface drainage away from the foundations of structures should be maintained and the

site should be graded to prevent the ponding of water.

Roadways

In general, for the light automobile traffic and drained subgrade conditions, an estimate of the roadway pavement thickness may be as follows:

1. Wearing course - 2-in. asphaltic concrete.
2. Base course - 6-in. base course over a prepared subgrade.
3. Subbase - 6-in. subbase course over a prepared subgrade.

Provisions should be made in the contract documents to allow for local adjustments regarding select borrow subbase and borrow requirements in the field in accordance with the design standards of the City and County of Honolulu. In fill areas, the use of select soils within the top 2 to 3 ft of the subgrade may reduce the thickness of or eliminate the need for the select borrow subbase or borrow courses.

The subgrade should be compacted and shaped to drain. To avoid the ponding of water and softening of the subgrade at low points, weep holes should be placed at subgrade levels thru the walls of catch basins which are placed in these low areas.

Utilities

Utilities should be placed after the fills are constructed. Utility lines should be designed with flexible joints, particularly where lines are connected to structures.

The bottoms of utility trenches should be daylighted and graded to shed water along the low side of the site. The backfill and drainage of utility trenches should be carefully designed.

Unforeseen Conditions

Because of the variability of soil deposits, site improvements, designs and construction techniques, conditions may be encountered that cannot be foreseen with even the most exhaustive studies of site and project conditions. These unforeseen conditions should be recognized and then evaluated so that the designs or the construction methods may be modified accordingly, if necessary.

Unforeseen or undetected conditions such as soft spots, existing utility trenches, structure foundations, voids or cavities, boulders, expansive soil pockets or seepage water, etc., may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

Site Regrading

After mass grading work is done and cuts and fills are made according to the grading plans, regrading at some future date should be avoided unless done under the guidance of a soils engineer.

PROPOSED SPECIFICATION FOR EARTHWORK

MOMILANI VILLA

General Description

This item shall consist of clearing and grubbing, preparing of land to be filled, excavating and filling of the land, spreading, compacting and testing of the fill, and subsidiary work for grading the site.

Clearing, Grubbing and Preparing Areas to be Filled

Vegetation, rubbish and miscellaneous material shall be removed and disposed of, leaving the disturbed area with a neat, debris-free appearance.

Topsoil, stockpiled soils and localized soft pockets shall be stripped to stiff natural ground before the placement of fills. Loose surface soils encountered at finish grade shall be scarified and recompacted.

Hard surfaces of existing haul roads shall be scarified down to stiff soils and recompacted to match the density of the surrounding soil.

The bottoms and sides of gullies or natural drainageways shall be stripped down to stiff natural ground before the placement of fills.

Subdrains shall be placed along the bottoms of natural drainageways before the placement of fills.

Where fills are constructed on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the fill shall be benched to a generally level condition. As the fill is constructed in approximately level layers, it shall continually be keyed into the stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.

Materials

Fill material shall consist of selected on-site soils or approved borrow soils. The soils shall contain no more than a trace of organic and deleterious matter.

Borrow soils shall be select soils generally less than 6-in. maximum size, with more than 30% fines and a plasticity index generally less than 20.

Fill material placed in the top 2 ft of fills shall contain less than 30% gravel.

Placing, Spreading and Compacting Fill Material

The selected fill material shall be placed in level layers which, when compacted, shall not exceed 6 inches. Each layer shall be spread evenly and blade-mixed during the spreading to attain uniformity of material and water content within each layer.

Rocks or cobbles shall not be allowed to nest and voids between rocks shall be filled and compacted with small stones or earth.

When the water content of the fill material is well below the optimum for compacting purposes, water shall be added until the water content is near the optimum.

When the water content of the material is well above the optimum for compacting purposes, the fill material shall be aerated by blading or by other satisfactory methods until the water content is near the optimum.

After each layer has been placed, mixed and spread evenly, it shall be compacted to 90% of maximum density in accordance with AASHO Test No. T-180-57 or other comparable density tests. For fills in roadway areas, the top 2 ft of fill shall be compacted to 95% of the maximum density. Compaction shall be with sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other acceptable rollers which shall be able to compact the fill to the specified density. Rolling shall be accomplished while the fill material is at the specified water content. The rolling of each layer shall be continuous over its entire area and the roller shall make sufficient passes to obtain the desired density.

Field density tests shall be made to get an indication of the compaction of the fill. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density readings shall be taken as often as necessary in the compacted material below the disturbed surface. When these readings indicate that the density of any layer of fill or portion thereof is below the required density, that layer or portion shall be reworked until the required density has been obtained.

The fill operation shall be continued in 6-in. compacted layers, as specified above, until the fill has been brought to the finished slopes and grades as shown on the accepted plans.

Boulder Fills

If boulders are used for the construction of fills, they shall be generally placed along the toe section of slopes. The subgrade shall be stripped to stiff natural ground, shaped to drain and a layer of select material or low grade concrete shall be placed on it. Voids shall be filled with smaller granular soils. A blanket of filter material shall be placed against the boulder fill before construction of fills against it.

Excavation

Suitable material from excavation shall be used in the fill and unsuitable material from excavation shall be disposed of.

Unforeseen Conditions

If unforeseen or undetected soil conditions such as soft spots, existing utility trenches, structure foundations, voids or cavities, boulders, seepage water or expansive soil pockets, etc., are encountered, corrective measures shall be made in the field as they are detected.

Rainy Weather

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until field tests indicate that the water content and density are as previously specified.

BORING LOGS

The stratification lines shown on each of the boring logs represent the approximate boundary between soil types and the transition may be gradual.

Symbols

Symbols used generally are in accordance with the Unified Soil Classification System.

Where a parenthesis "(MH)" is used, the soil sample was classified by visual observation of the sample recovered.

Where no parenthesis "MH" is used, the soil sample was classified from either the Atterberg limit or sieve analysis test results.

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT MOMILANI VILLA

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

HAMMER:
Weight 140#
Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

BORING NO. 1 Sheet No. ____ of ____

Driller W. LUM ASSOC., INC. Date SEPT. 20, 1973

Field Party RADOVICH, OSHIRO

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 125'± * Datum —

Drill Bit FINGER TYPE

Water Level	NOT NOTICED	16.0'		
Time	—	—		
Date	9-20-73	9-21-73		

Unified Soil Classification	DESCRIPTION ELEV. = 125'± * 2.0	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA Standard Penetration Test N (Blows per foot) 0 10 20 30 40
(MH)	STIFF, BROWN CLAYEY SILT W/TRACES OF ROOTS			1-A	—	23	—	—	—	
(SM)	DENSE, BROWN SILTY SAND W/GRAVEL	5		1-B	—	12	—	—	—	18/0.5' 40/0.4'
	COBBLES OR BOULDERS									
	STIFF MOTTLED GRAY CLAYEY SILT & DECOMPOSED ROCK	10		1-C	—	40	—	—	—	65
		15	WATER 9-20-73	1-D	—	50	—	—	—	
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/ DECOMPOSED ROCK & GRAVEL									
		20		1-E	—	60	—	—	—	50
	END OF BORING @ 21.5' 9-20-73									

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

10-16-73 BC

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC.

3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

BORING NO. 2 Sheet No. ____ of ____

PROJECT MOMILANI VILLA

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii

Tax Map Key: 9-6-04: 10 & 9-7-25: 13

Driller W. LUM ASSOC., INC. Date SEPT. 21, 1973

Field Party RADOVICH, OSHIRO

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 129'± * Datum —

Drill Bit FINGER TYPE

Water Level NOT NOTICED

Time —

Date 9-21-73

HAMMER:

Weight 140#

Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot)
	ELEV. = 129'± *	0								
MH	STIFF, BROWN SILTY CLAY W/SOME SAND & GRAVEL			2-A	-	27	-	-	-	
	COBBLES & BOULDERS	5		2-B	-	-	-	-	-	50/0.1'
		10		2-C	-	36	-	-	-	
(MH)	STIFF, MOTTLED BROWN CLAYEY SILT W/ SOME DECOMPOSED ROCK	15		2-D	-	54	-	-	-	
	END OF BORING @ 16.5' 9-21-73									

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

BORING NO. 3 Sheet No. ____ of ____

Driller W. LUM ASSOC., INC. Date SEPT. 20, 1973

PROJECT MOMILANI VILLA

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

Field Party RADOVICH, OSHIRO

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 137' ± * Datum —

Drill Bit FINGER TYPE

HAMMER:
Weight 140#
Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

Water Level NOT NOTICED
Time —
Date 9-20-73

Unified Soil Classification	DESCRIPTION ELEV. = 137' ± * 20	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA Standard Penetration Test N (Blows per foot) 0 10 20 30 40
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/SOME SAND & GRAVEL			3-A	-	22	—	—	-	26/0.1'
	COBBLES & BOULDERS									
		5		3-B	ROCK FRAGMENTS					46/0.1'
	END OF BORING @ 5.5' 9-20-73									

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT MOMILANI VILLA
LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

HAMMER:
Weight 140#
Drop 30"
SAMPLER: 2" STANDARD SPLIT SPOON

BORING NO. 4 Sheet No. ____ of ____
Driller W. LUM ASSOC., INC. Date SEPT. 21, 1973
Field Party RADOVICH, OSHIRO
Type of Boring AUGER (MOBILE B-50) Diam. 4"
Elev. 139' ± * Datum —
Drill Bit FINGER TYPE

Water Level	NOT NOTICED			
Time	—			
Date	9-21-73			

ELEV. = 139' ± * 20

Unified Soil Classification	Description	Depth (Ft.)	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	Standard Penetration Test N (Blows per foot)
(MH)	STIFF, BROWN SILTY CLAY		4A	–	25	–	–	–	
CH	STIFF, BROWN CLAY W/SOME GRAVEL	5	4B	32	24	77	–	–	
(MH)	STIFF, MOTTLED BROWN CLAYEY SILT (DECOMPOSED ROCK)	10	4C	–	37	–	–	–	
(MH)	STIFF, BROWN SILTY CLAY W/TRACES OF SAND & GRAVEL	15	4D	–	30	–	–	–	
	END OF BORING @ 16.5' 9-21-73								

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI - VILLA

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT: MOMILANI VILLA

LOCATION: Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

HAMMER:
Weight: 140#
Drop: 30"

SAMPLER: 2" STANDARD SPLIT SPOON

BORING NO. 5 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: SEPT. 22, 1973
Field Party: RADOVICH, KAKU, OSHIRO
Type of Boring: AUGER (MOBILE B-50) Diam. 4"
Elev. 202' ± * Datum: –
Drill Bit: FINGER TYPE

Water Level: NOT NOTICED
Time: –
Date: 9-22-73

ELEV. = 202' ± * 2 0

Unified Soil Classification	Description	Depth (Ft.)	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	Standard Penetration Test N (Blows per foot)
			5-A	34	32	74	–	–	
CH	STIFF, REDDISH BROWN CLAY W/ GRAVEL & SAND								
		5	5-B	–	28	–	–	–	
CH	STIFF, REDDISH BROWN CLAY	10	5-C	33	33	82	–	–	
	BOULDER								
(MH)	STIFF, MOTTLED BROWN CLAYEY SILT W/ DECOMPOSED ROCK & GRAVEL	15	5-D	–	40	–	–	–	50/0.2' HAMMER BOUNCES
	BOULDERS ?								
(MH)	STIFF, MOTTLED BROWN CLAYEY SILT W/ GRAVEL & DECOMPOSED ROCK								
	BOULDERS OR ROCK ?	20	5-E		NO RECOVERY				50/0.0' HAMMER BOUNCES
	END OF BORING @ 20' 9-22-73								

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC.

3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

PROJECT MOMILANI VILLA

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

HAMMER:
Weight 140#
Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

BORING NO. 6 Sheet No. ____ of ____
Driller W. LUM ASSOC., INC. Date SEPT. 20, 1973
Field Party RADOVICH, OSHIRO
Type of Boring AUGER (MOBILE B-50) Diam. 4"
Elev. 158' ± * Datum —
Drill Bit FINGER TYPE
Water Level NOT NOTICED
Time —
Date 9-20-73

Unified Soil Classification	DESCRIPTION ELEV. = 158' ± * 20	Depth (Ft.)	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test N (Blows per foot) 0 10 20 30 40
MH	STIFF, BROWN SILTY CLAY W/ ROOTS		6-A	40	29 5	79	—	—	
	COBBLE OR BOULDER								
	SILTY CLAY ?								
	COBBLE OR BOULDER	5							
			6-B	—	23	—	—	—	50/0.2'
	GRAY DECOMPOSED ROCK W/ COBBLES & CLAYEY SILT	10	6-C	—	24	—	—	—	45/0.3'
		15							
(MH)	STIFF LIGHT MOTTLED BROWN CLAYEY SILT W/ GRAY CLAY POCKETS		6-D	—	50	—	—	—	
(MH)	STIFF, MOTTLED BROWN CLAYEY SILT	20	6-E	—	53	—	—	—	
	END OF BORING @ 21.5' 9-20-73								

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI VILLA

WALTER LUM ASSOCIATES, INC.

3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

BORING NO. 7 Sheet No. ____ of ____

PROJECT MOMILANI VILLA

Driller W. LUM ASSOC., INC. Date SEPT. 21, 1973

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii

Tax Map Key: 9-6-04: 10 & 9-7-25: 13

Field Party RADOVICH, OSHIRO

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 158'± * Datum —

Drill Bit FINGER TYPE

HAMMER:

Weight 140#

Drop 30"

Water Level NOT NOTICED

Time —

Date 9-21-73

SAMPLER: 2" STANDARD SPLIT SPOON

ELEV. = 158'± * 2 0

Unified Soil Classification	Description	Depth (Ft.)	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	Standard Penetration Test N (Blows per foot)
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/TRACES OF SAND & GRAVEL COBBLE OR BOULDER	0	7-A	-	20	-	-	-	40/0.4'
MH	STIFF LIGHT MOTTLED BROWN SILTY CLAY W/ DECOMPOSED ROCK	5	7-B	33	18	59	-	-	
	STIFF, MOTTLED BROWN CLAYEY SILT W/SAND & GRAVEL COBBLE OR BOULDER END OF BORING @ 10.8' 9-21-73	10	7-C	-	13	-	-	-	40/0.3'

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

BORING NO. 8 Sheet No. ____ of ____

PROJECT MOMILANI VILLA

Driller W. LUM ASSOC., INC. Date SEPT. 22, 1973

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii

Field Party RADOVICH, KAKU, OSHIRO

Tax Map Key: 9-6-04: 10 & 9-7-25: 13

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 200' ± * Datum —

HAMMER:

Weight 140#

Drop 30"

Drill Bit FINGER TYPE

Water Level NOT NOTICED

Time —

Date 9-22-73

SAMPLER: 2" STANDARD SPLIT SPOON

Unified Soil Classification	DESCRIPTION ELEV. = 200' ± * 1.0	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA Standard Penetration Test N (Blows per foot)
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/TRACES OF DECOMPOSED ROCK & ROOTS			8-A	–	28	–	–	–	49
(MH)	STIFF, DARK REDDISH BROWN SILTY CLAY W/TRACES OF DECOMPOSED ROCK & ROOTS									
CH	STIFF MOTTLED DARK BROWN CLAY	5		8-B	32	25	75	–	–	69
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/TRACES OF DECOMPOSED ROCK & ROOTS	10		8-C	–	25	–	–	–	60
(MH-CH)	STIFF, REDDISH BROWN SILTY CLAY W/ GRAY CLAY POCKETS	15		8-D	–	29	–	–	–	40/0.3' HAMMER BOUNCES
(MH)	STIFF, MOTTLED BROWN SILTY CLAY W/ TRACES OF SAND	20		8-E	–	28	–	–	–	50/0.3' HAMMER BOUNCES

END OF BORING @ 20.8'
9-22-73

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MoMILANI VILLA

WALTER LUM ASSOCIATES, INC. 3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

Boring Log

BORING NO. 9 Sheet No. ____ of ____

PROJECT MOMILANI VILLA

LOCATION Manana-Uka & Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: 10 & 9-7-25: 13

Driller W. LUM ASSOC., INC. Date SEPT. 22, 1973

Field Party RADOVICH, KAKU, OSHIRO

Type of Boring AUGER (MOBILE B-50) Diam. 4"

Elev. 158'± * Datum —

Drill Bit FINGER TYPE

HAMMER:
Weight 140#
Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

Water Level NOT NOTICED
Time —
Date 9-22-73

PENETRATION DATA

Unified Soil Classification	DESCRIPTION ELEV. = 158'± * Jo	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	Standard Penetration Test N (Blows per foot) 0 10 20 30 40
(MH)	STIFF, TANNISH BROWN CLAYEY SILT W/ DECOMPOSED ROCK			9-A	–	22 29	–	–	–	50/0.5'
		5		9-B	39	40	70	–	–	
MH	STIFF MOTTLED BROWN & ORANGE CLAYEY SILT W/TRACES OF DECOMPOSED ROCK & GRAY, CLAY POCKETS	10		9-C	–	48	–	–	–	
		15		9-D	55	54	84	–	–	
	END OF BORING @ 16.5' 9-22-73									

*Elevation estimated from Contour Map by Park Engineering, Inc. dated 4-21-72

MOMILANI VILLA

TABLE I A - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	2	4	5	5
SAMPLE NO.		B	A	C
DEPTH BELOW SURFACE	SURFACE	5'-6.3'	0.5'-2'	10'-11.5'
DESCRIPTION	BROWN SILTY CLAY W/SOME SAND & GRAVEL	BROWN CLAY W/SOME GRAVEL	REDDISH-BROWN CLAY W/GRAVEL & SAND	REDDISH-BROWN CLAY
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1"				
1/2"				
#4				
#10				
#20				
#40				
#100				
#200				
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL	NATURAL	NATURAL
Liquid Limit	62	77	74	82
Plastic Limit	36	32	34	33
Plasticity Index	26	45	40	49
Dilatancy	MEDIUM	SLOW	NONE	NONE
Toughness	MEDIUM	HIGH	MEDIUM	HIGH
Dry Strength	MED.-HIGH	HIGH	HIGH	HIGH
UNIFIED SOIL CLASSIFICATION	MH	CH	CH	CH
APPARENT SPECIFIC GRAVITY	2.88			
EXPANSION AND CBR TESTS				
(Surcharge-51 P.S.F.)				
Molding Moisture, %	27.3			
Molding Dry Density, P.C.F.	93.1			
Swell upon saturation, %	1.3			
CBR at 0.1" Penetration	10.0			
MOISTURE-DENSITY RELATIONS OF SOILS				
(AASHO T-180-57 Method___)	A			
Dry to Wet or Wet to Dry	DRY TO WET			
Max. Dry Density (P.C.F.)	92.7			
Optimum Moisture (%)	28.0			

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 10-15-73 By BT

MOMILANI VILLA

TABLE IB - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	6		7	
SAMPLE NO.			B	
DEPTH BELOW SURFACE	SURFACE		5'-6.5'	
DESCRIPTION	BROWN SILTY CLAY W/GRASS & ROOTS		LIGHT MOTTLED BROWN SILTY CLAY W/DECOMP. ROCK	
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"				
1/2"				
#4				
#10				
#20				
#40				
#100				
#200				
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL		NATURAL	
Liquid Limit	79		59	
Plastic Limit	40		33	
Plasticity Index	39		26	
Dilatancy	SLOW-MED.		SLOW	
Toughness	MED.-HIGH		MEDIUM	
Dry Strength	MED.-HIGH		MED.-HIGH	
UNIFIED SOIL CLASSIFICATION	MH		MH	
APPARENT SPECIFIC GRAVITY				
EXPANSION AND CBR TESTS (Surcharge-51 P.S.F.)				
Molding Moisture, %	33.0			
Molding Dry Density, P.C.F.	81.6			
Swell upon saturation, %	4.3			
CBR at 0.1" Penetration	5.7			
MOISTURE-DENSITY RELATIONS OF SOILS				
(AASHO T-180-57 Method ___)	A			
Dry to Wet or Wet to Dry	DRY TO WET			
Max. Dry Density (P.C.F.)	87.0			
Optimum Moisture (%)	32.4			

REMARKS:

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 10-15-73 By BT

MOMILANI VILLA

TABLE I C - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	8	9	9	
SAMPLE NO.	B	B	D	
DEPTH BELOW SURFACE	5'-6.5'	5'-6.5'	15'-16.5'	
DESCRIPTION	MOTTLED DARK BROWN CLAY	MOTTLED BROWN & ORANGE CLAYEY SILT W/TRACES OF DECOMP. ROCK & GRAY CLAY POCKETS	MOTTLED BROWN & ORANGE CLAYEY SILT W/TRACES OF DECOMP. ROCK & GRAY CLAY POCKETS	
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"				
1/2"				
#4				
#10				
#20				
#40				
#100				
#200				
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL	NATURAL	
Liquid Limit	75	70	84	
Plastic Limit	32	39	55	
Plasticity Index	43	31	29	
Dilatancy	SLOW	SLOW	SLOW	
Toughness	HIGH	MEDIUM	MEDIUM	
Dry Strength	HIGH	SLIGHT-MED.	SLIGHT-MED.	
UNIFIED SOIL CLASSIFICATION	CH	MH	MH	
APPARENT SPECIFIC GRAVITY				
EXPANSION AND CBR TESTS (Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-57 Method___)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

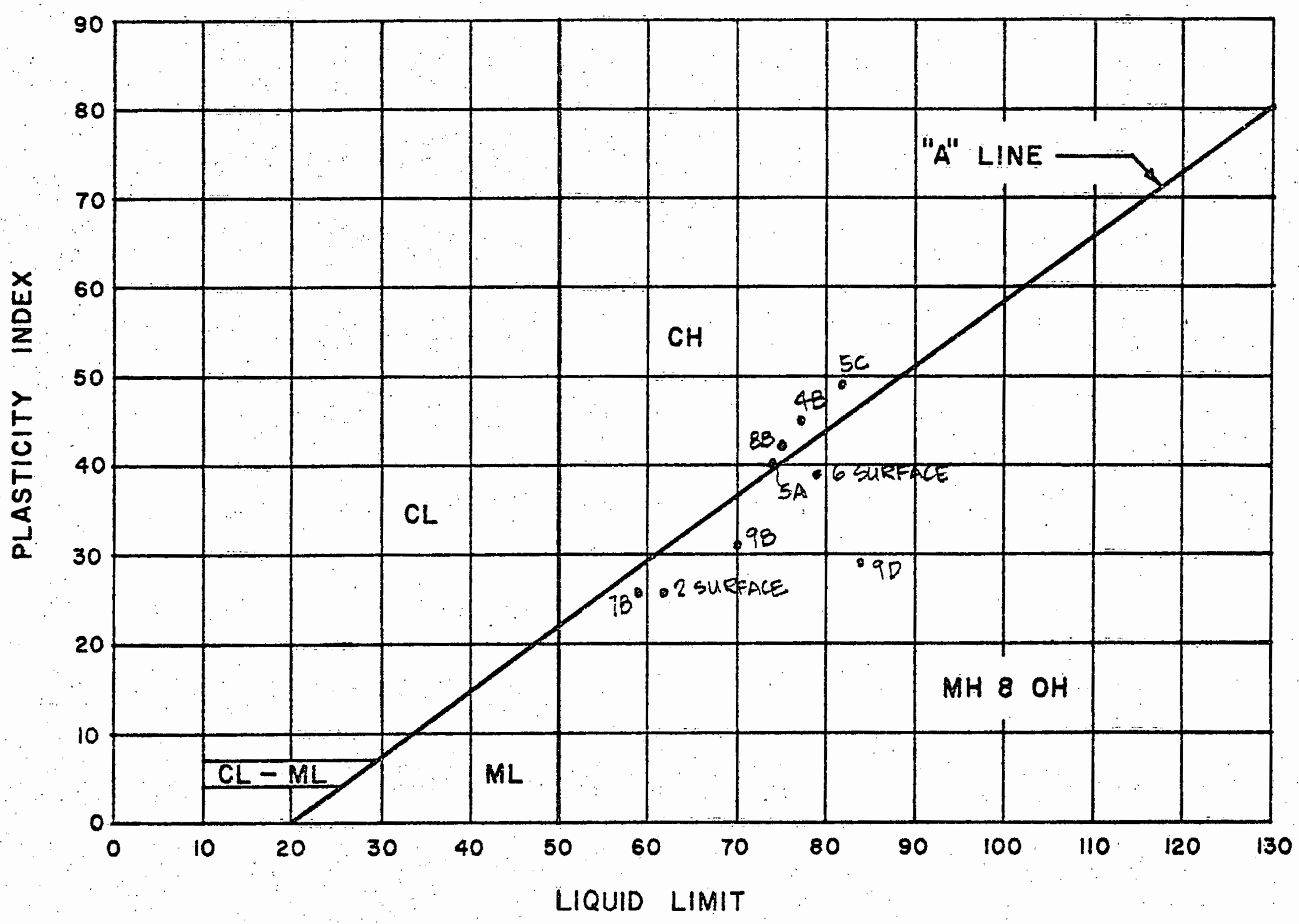
WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 10-15-73 By BT

PLASTICITY CHART

PROJECT: MOMILANI VILLA

LOCATION: MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII



DATE 10-15-73 BY BT

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

-872

MOISTURE–DENSITY CURVE (AASHO T-180-57, METHOD A)

PROJECT: MOMILANI VILLA

LOCATION: MANANA-UKA & WAIAWA, EWA, OAHU, HI

SAMPLE NO.: 2 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY CLAY W/SOME SAND & GRAVEL

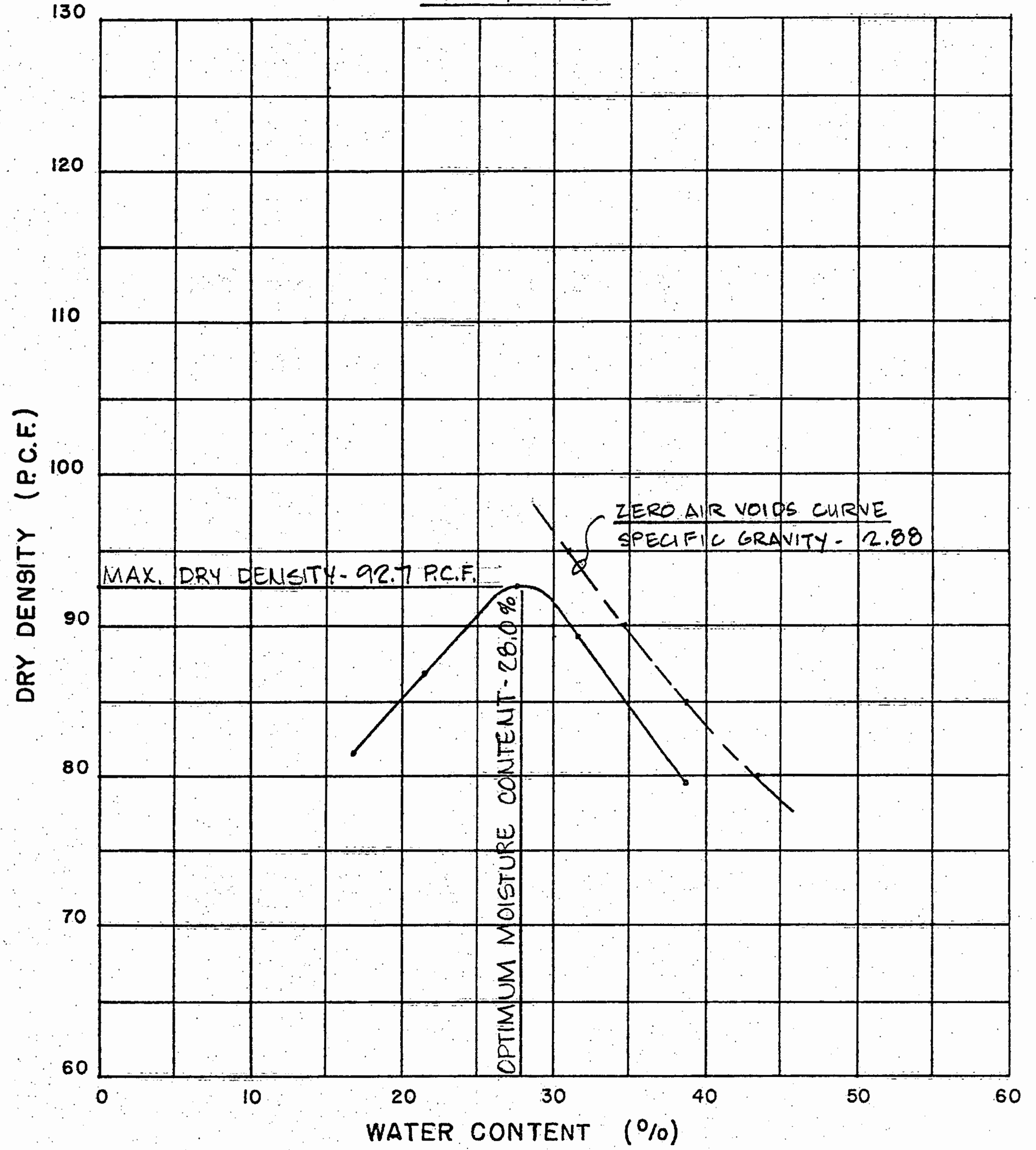
AGGREGATE: 1/4" MINUS

MOLD SIZE: 4"Φ X 4.584" HIGH

HAMMER: 10 LBS, 18" DROP

LAYERS: 5

BLOWS: 25/LAYER



WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

DATE 10-1-73 BY NI

-470

MOISTURE—DENSITY CURVE (AASHO T-180-57, METHOD A)

PROJECT: MOMILANI VILLA

LOCATION: MANANA-UKA & WAIAWA, EWA, OAHU, HI

SAMPLE NO.: 6 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY CLAY W/GRASS & ROOTS

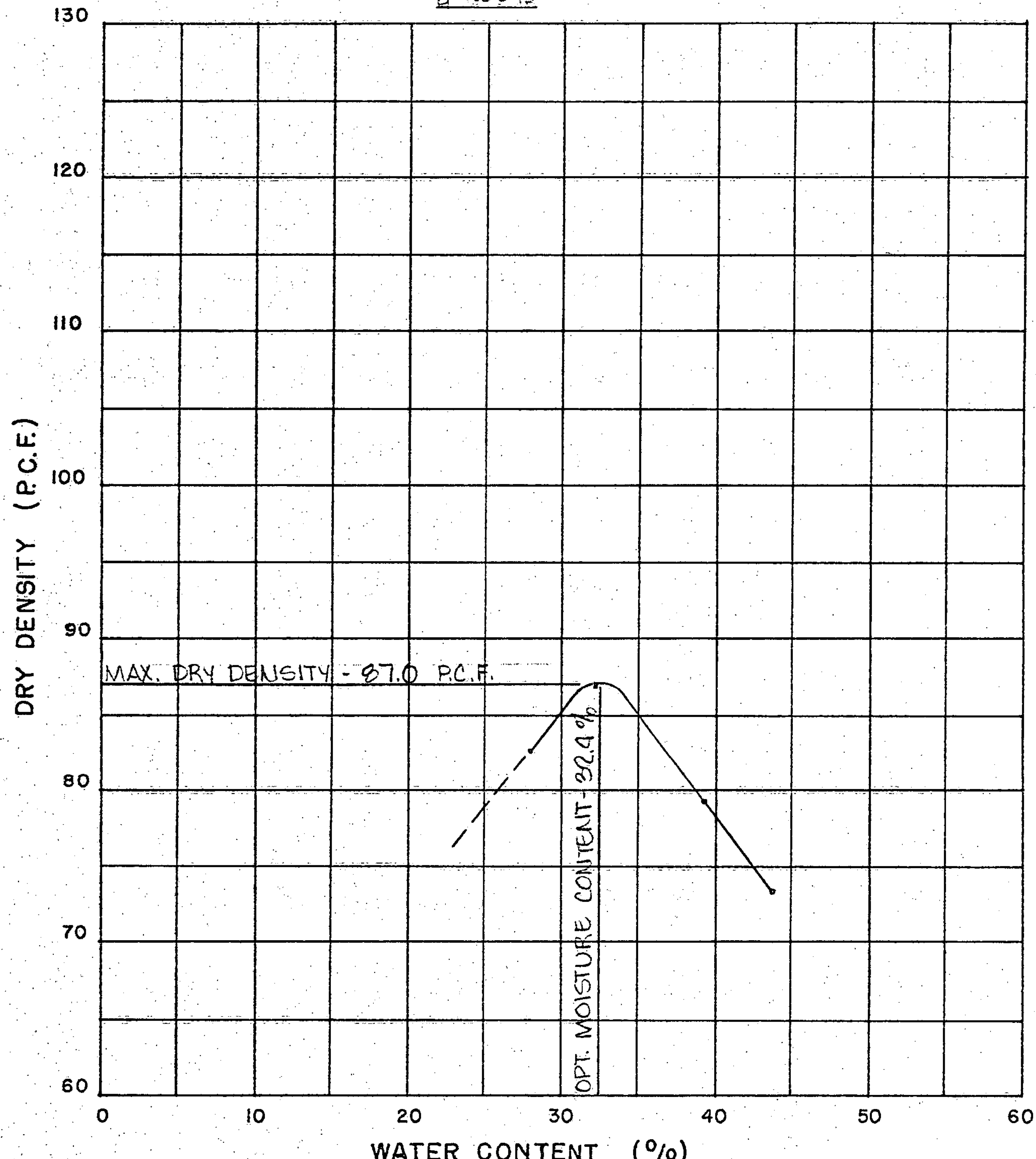
AGGREGATE: 1/4" MINUS

MOLD SIZE: 4"Φ X 4.584" HIGH

HAMMER: 10 LBS 18" DROP

LAYERS: 5

BLOWS: 25/LAYER



WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

DATE 10-8-73 BY NI

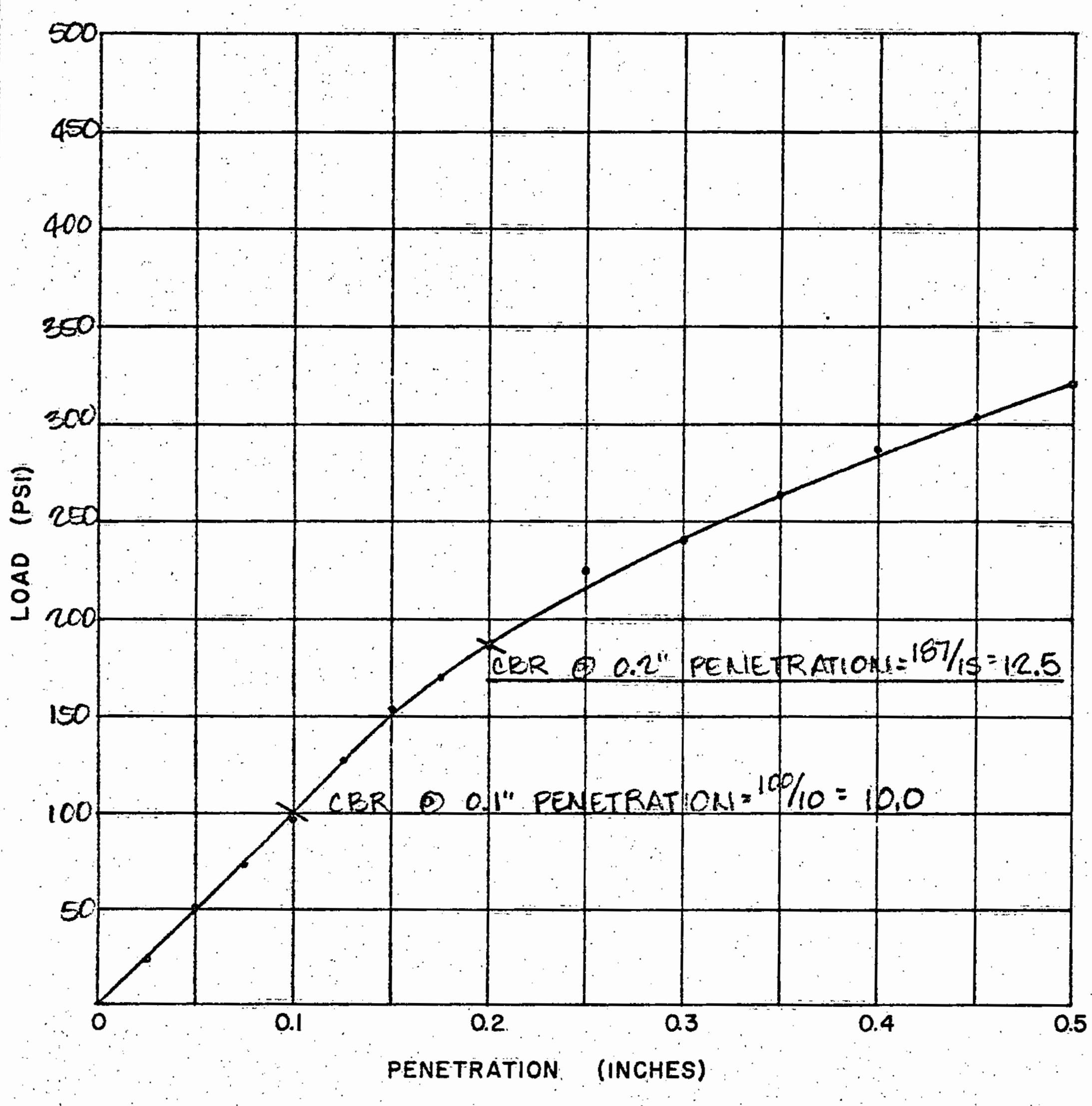
CBR TEST

PROJECT: MOMILANI VILLA

LOCATION: MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII

SAMPLE NO: 2 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY CLAY W/SOME SAND & GRAVEL



CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS.)	LOAD (PSI)
0.025	70	23
0.050	150	50
0.075	220	73
0.100	290	97
0.125	380	127
0.150	460	153
0.175	510	170
0.200	560	187
0.250	630	210
0.300	720	240
0.350	790	263
0.400	860	287
0.450	910	303
0.500	960	320

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS
HAMMER DROP 18"
No. OF BLOWS 56/LAYER
No. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, %. 27.3
MOLDING DRY DENSITY, P.C.F. 93.1
CBR @ 0.1" PENETRATION 10.0
DAYS SOAKED 4

DATE 10-3-73 BY RH
DATE 10-4-73 BY NI

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

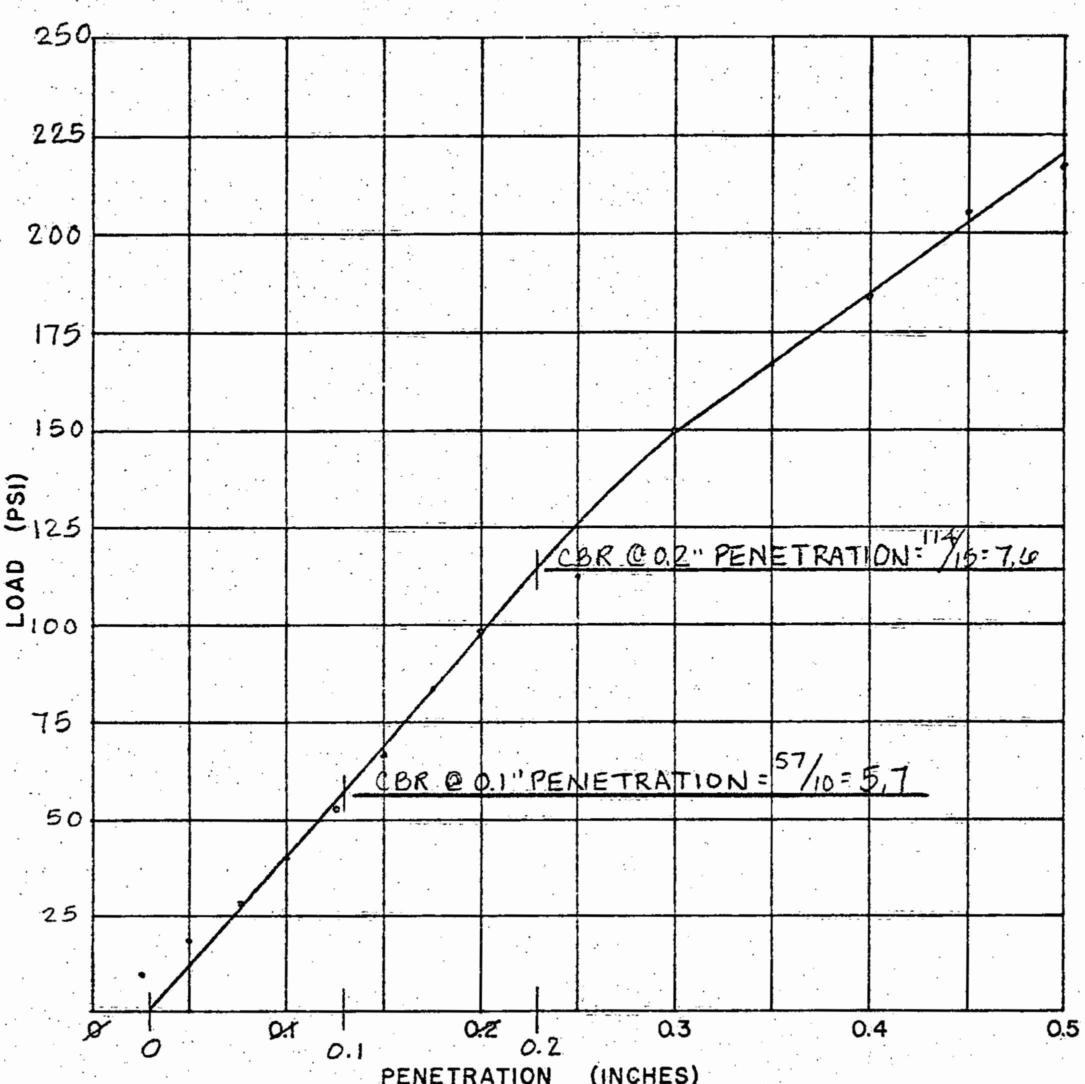
CBR TEST

PROJECT: MOMILANI VILLA

LOCATION: MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII

SAMPLE NO: 6 SURFACE

SAMPLE DESCRIPTION: BROWN SILTY CLAY W/GRASS & ROOTS



CBR PENETRATION DATA

PENETRATION (INCHES)	LOAD (LBS)	LOAD (PSI)
0.025	28	9
0.050	55	18
0.075	84	28
0.100	119	40
0.125	158	53
0.150	202	67
0.175	250	83
0.200	294	98
0.250	336	112
0.300	450	150
0.350	500	167
0.400	550	183
0.450	615	205
0.500	680	227

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS
HAMMER DROP 18"
No. OF BLOWS 56/LAYER
No. OF LAYERS 5

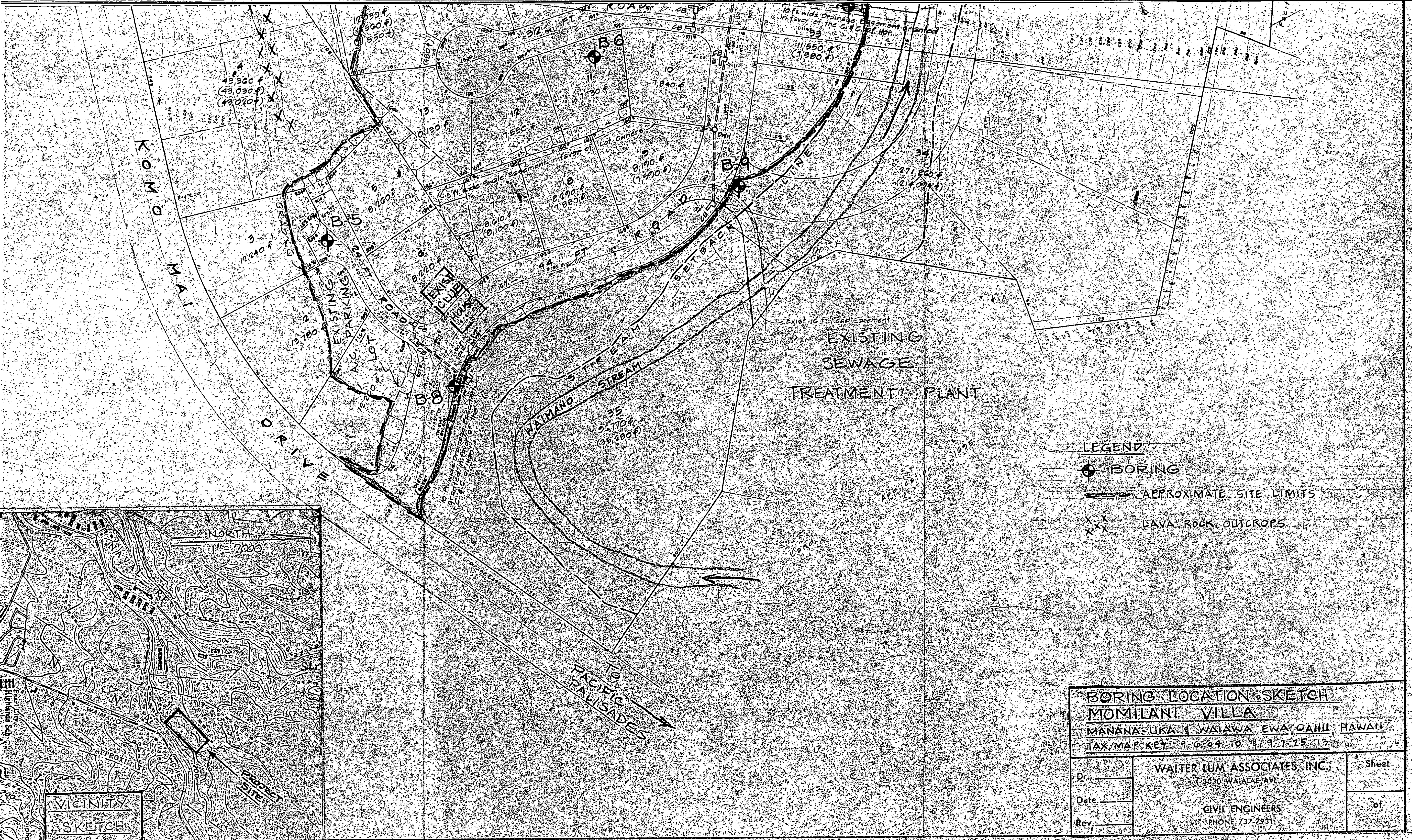
ADJUSTED COORDINATES

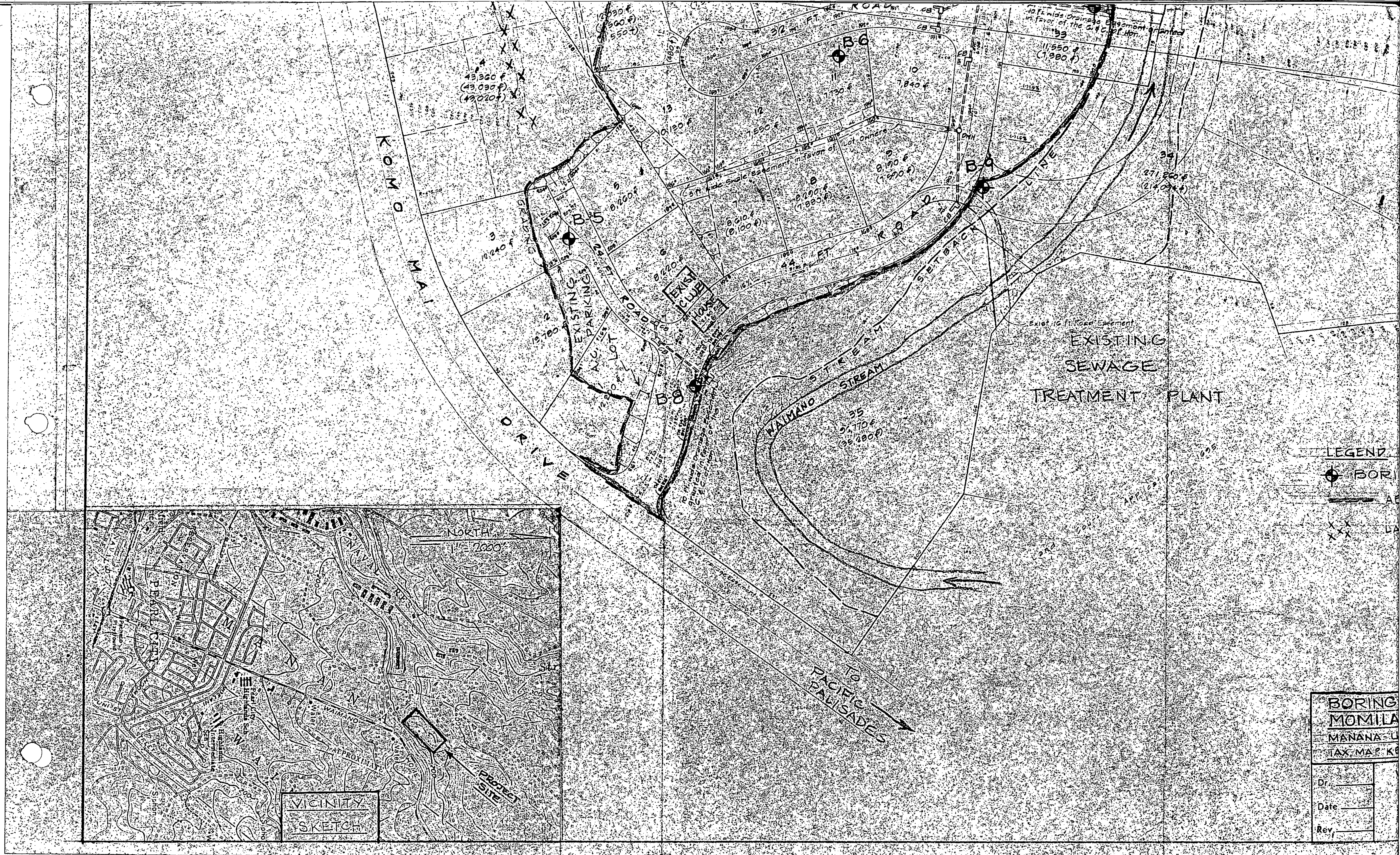
TEST RESULTS:

MOLDING MOISTURE, %. 33.0
MOLDING DRY DENSITY, P.C.F. 81.6
CBR @ 0.1" PENETRATION 5.7
DAYS SOAKED 4

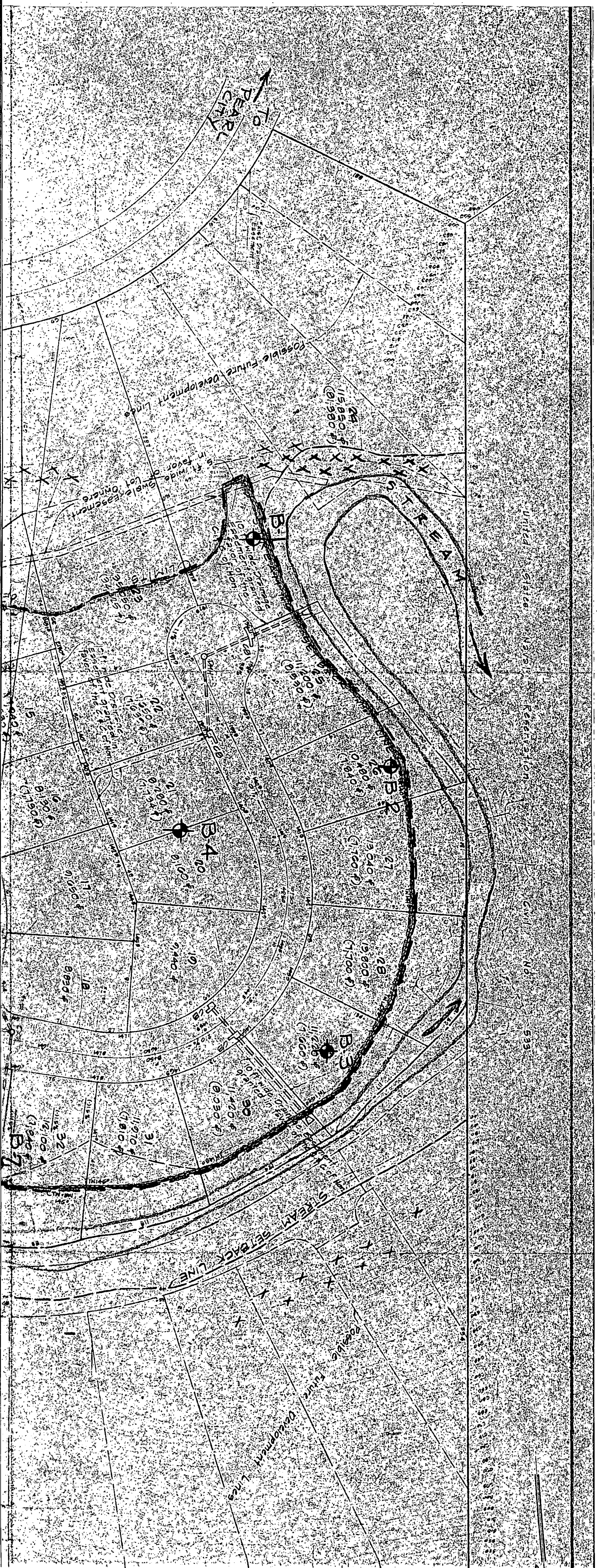
DATE 10-8-73 BY RH
DATE 10-9-73 BY JS

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

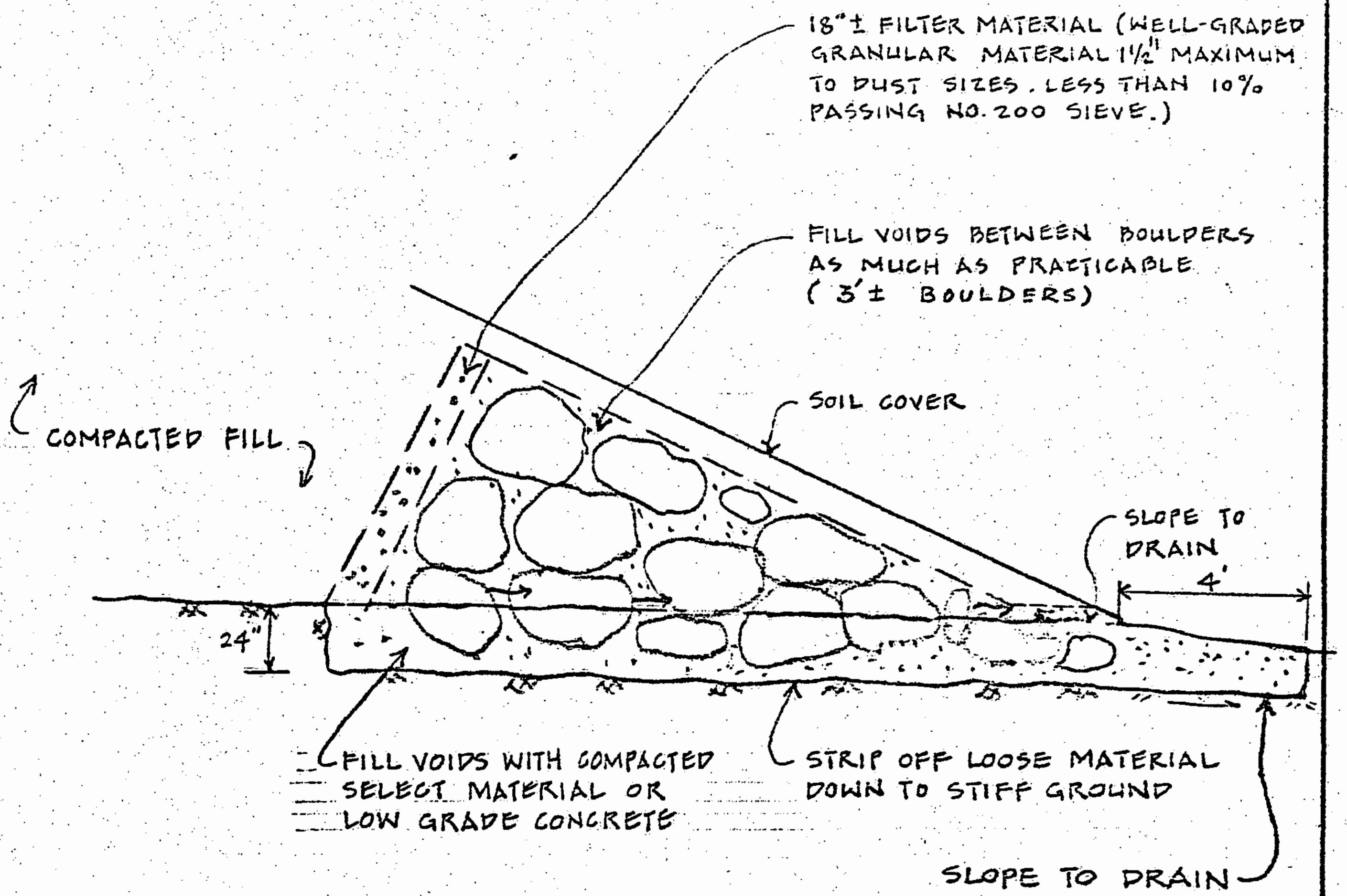

BORING LOCATION SKETCH
MOMILANI VILLA
MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: 10 & 9-7-25: 13
WALTER LUM ASSOCIATES, INC.
3030 WAIALAE AVE.
CIVIL ENGINEERS
PHONE 737-7931
Dr.
Date
Rev.
Sheet
of
LEGEND
BORING
APPROXIMATE SITE LIMITS
LAVA ROCK OUTCROPS
EXISTING SEWAGE TREATMENT PLANT
KOMO MAI DRIVE
TO PACIFIC PALISADES
WAIMANO STREAM
STREAM SETBACK LINE
EXISTING PARKING
A.C. LOT
EXIST. CLUB HOUSE
24 FT. ROAD
44 FT. ROAD
32 FT. ROAD
GRADING
B-5
B-6
B-8
B-9
Exist. 10 Ft. Road Easement
10 Ft. wide Drainage Easement granted in favor of the City & C. of Hon.
5 Ft. wide Sewer Easement in favor of Lot Owners
NORTH
1" = 2000'
VICINITY SKETCH
PROJECT SITE
WAIMANO



KOMO MAI DRIVE
EXISTING PARKING A.C. LOT
GRADING
24 FT. ROAD
44 FT. ROAD
32 FT. ROAD
EXIST. CLUB HOUSE
B5
B6
B8
B9
SETBACK LINE
WAIMANO STREAM
EXISTING SEWAGE TREATMENT PLANT
TO PACIFIC PALISADES
LEGEND
BORI
BORING
MOMILA
MANANA
TAX MAP KE
Dr.
Date
Rev.
VICINITY SKETCH
NORTH
1" = 2000'
PROJECT SITE
PEARL CITY
Pearl City Highlands Sch
Highlands Intermediate Sch
WAIMANO
APPROXIMATE
Siphon


TO PEARL CITY
Possible Future Development Line
STREAM
STREAM SETBACK LINE
B2
B3
B4
United States Navy Recreation Center

STREAM
STREAM SETBACK LINE
Possible Future Development Lines
B1
B2
B3
B4
TRUE NORTH
SCALE 1"=80'



SECTION
NOT TO SCALE

FIGURE 1
PROPOSED BOULDER FILL
MOMILANI VILLA
MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04:10 & 9-7-25:13

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

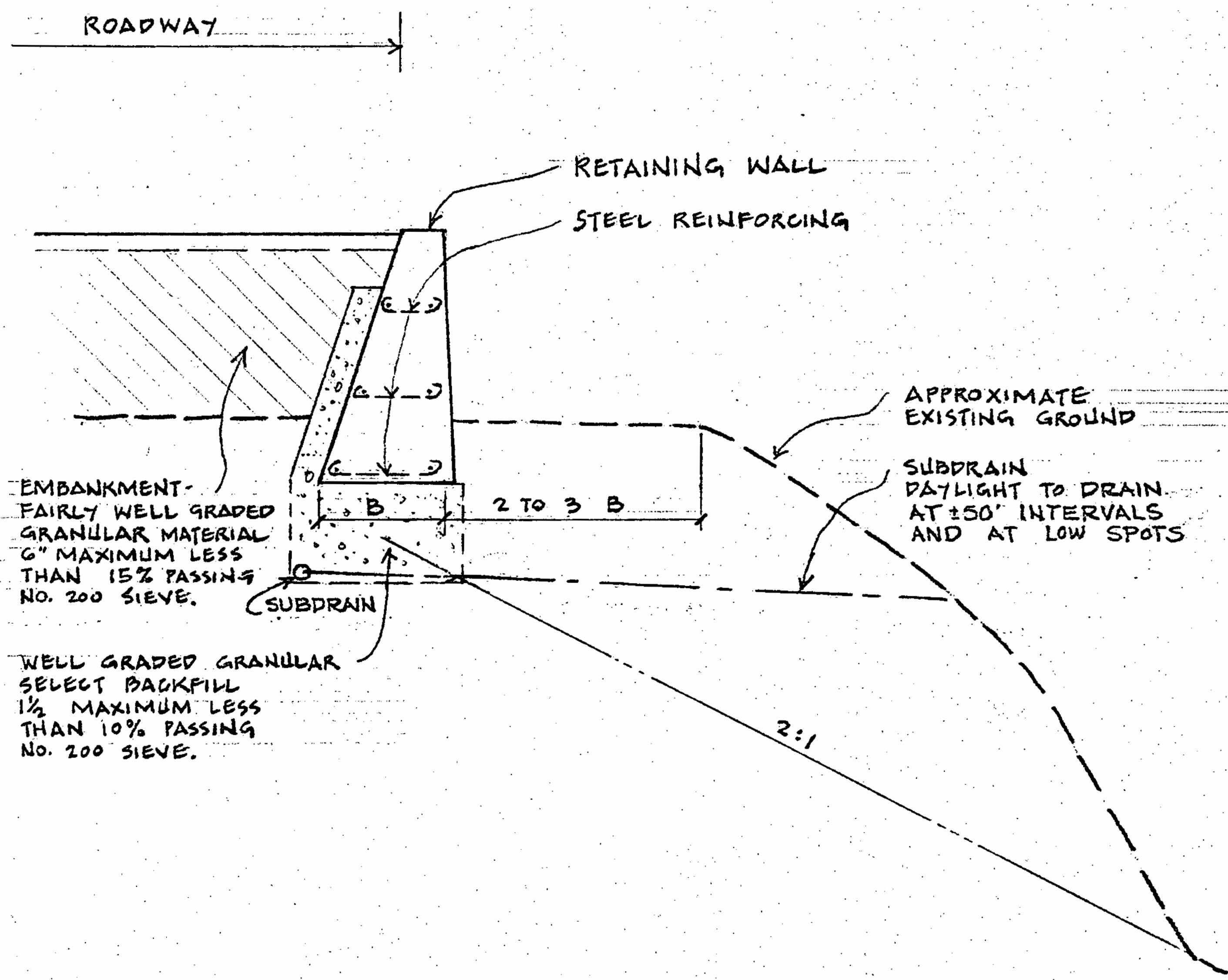


FIGURE 2
SUGGESTED RETAINING WALL AND FILL FOR ENTRY ROAD
MANANA-UKA & WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04:10 & 9-7-25:13

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

NOVEMBER 23, 1973

LIMITATIONS

In general, soil formations are commonly erratic and rarely uniform or regular. The boring logs indicate the approximate subsurface soil conditions encountered only at the drill holes where the borings were made at the times designated on the logs and may not represent conditions at other locations or at other dates. Soil conditions and water levels may change with the passage of time and construction methods or improvements at the site.

During construction, should subsurface conditions much different from those in the borings be observed, encountered, or otherwise indicated, we should be advised immediately to review or reconsider our recommendations in light of the new developments.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes, plan changes, or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the recommendations considering the time lapse, changed conditions, and changes in the state of the art of soil engineering.

Our professional services were performed, findings obtained and recommendations prepared in accordance with generally accepted engineering practices. This warranty is in lieu of all other warranties expressed or implied.